Docket No.: 1823-0130PUS1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent application of:
Hiromi YOKOTA et al.

Application No.: 10/585,993 Confirmation No.: 8867

Filed: July 13, 2006 Art Unit: 1793

For: PB-FREE COPPER-ALLOY SLIDING MATERIAL Examiner: C.A. Fogarty

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Hiromi Yokota, declare and say as follows:

I am familiar with U.S. Application Serial No. 10/585,993 of which I am a co-inventor. I have reviewed all Office Actions issued in connection with this application. I have also reviewed all of the references cited by the Examiner in these Office Actions.

I. Particle Diameters Of Hard Particles And Bi Particles

This document discusses particle diameters of hard particles and Bi particles disclosed in the present invention and GB 2355016A (hereinafter referred to as "GB '016").

In order to clarify a difference between the present case and GB '016, the structural charts of both cases were subjected to an image analysis, by me or by a technician under my direct supervision, and the size of Bi phases and hard particles were measured by the following procedure.

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Fig.1

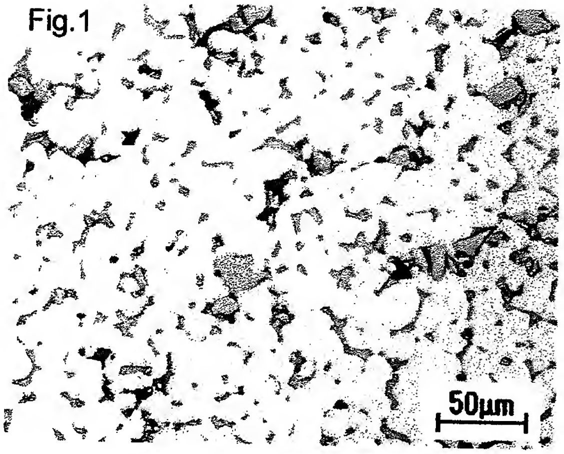
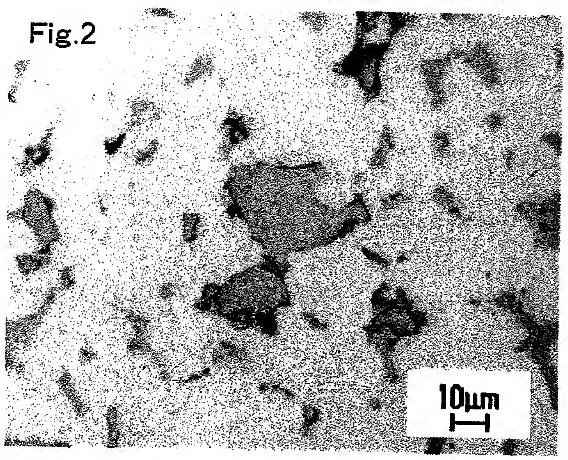
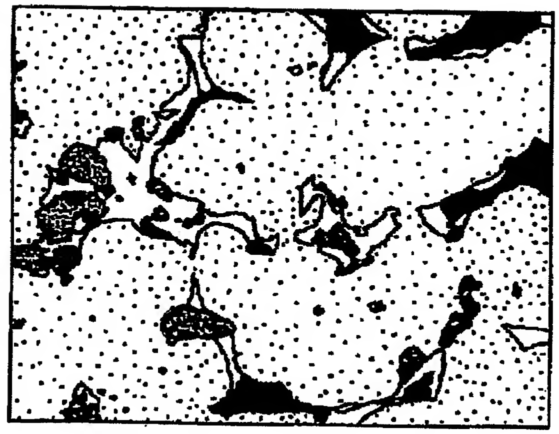


Fig.2



GB016

Fig.1A



An image analysis was carried out with LUZEX (product of Nireco Co., Ltd., type LS). This apparatus is installed in as research division of TAIHO KOGYO CO.

		Addition Amount, %		Particle Diameter (Circle Equivalent Diameter), μm	
		Bi	Hard Particles	Bi phase	Hard Particles
Present Case	Fig. 1 (Fig. 2)	10	3	7	17(15)*
GB '016	Fig. 1A	8	1.5	28	17(10)

The values in (   ) are described in the statements and tables of the present patent application. Hard particles having 15 μm of the particle diameter are described in Table 1, No.4 of the present patent application. Hard particles having 10 μm of the particle size described in Table 1, No. 4 of GB '016

The difference between the two values of the hard particles may be attributable to different measuring methods.

In conclusion, in the present invention the average particle diameter of Bi phase (D_{Bi}) is smaller than that of the hard particles (D_H), i.e., $D_{Bi}<D_H$. In GB'016, $D_{Bi}>D_H$.

II. Remarks

II-A. Invention of claims 1, 2, 5 and 6

In one aspect of the present invention, a lead-free copper-based sintered alloy is characterized by the following properties:

1. The composition contains 1-30 mass % of Bi;
2. The composition contains 0.1-10 mass % of hard particles which have an average particle diameter of 10-50 μm;
3. The composition (as recited in claim 2) contains at least one of:
   a. 1-15 mass % of Sn;
   b. 0.1-5 mass % of Ni; and
   c. 0.5 mass % or less of P; and
4. The Bi phase has smaller average particle diameter than the hard particles.

II-A-i - Issue 1: Relative size of Bi phase and hard particles

The claimed invention recites that the Bi phase has smaller average particle diameter than the hard particles. GB '016 does not specifically mention the size of the Bi phase relative to that of the hard particles. In the sintered alloy of GB '016, the composition contains 1-20 mass % of Bi, which have a preferred grain size of "not more than 250μm" (page 9, lines 10-12). The hard particles are present at 0.1-10 vol % and have a particle size of 1-45 μm. Initially, I would like to point out that in GB '016, the size of the hard particles is in reference to a sliding material while the size of the Bi is in reference to a powder. The Bi powder is mixed with, for example, Cu powder and the mixture is then sintered. Therefore, the measurement of "250 μm or less" does not refer to the size of Bi in the sintered material. Further, as discussed in greater detail below, the size of Bi particles before sintering does not determine the size of the particles in the sintered product.

The Examiner's basis for finding that GB '016 teaches Bi phase particles which are smaller than the hard particles appears to lie in the statement that "Bi is prevented to

flow out from its initial position through coexisting hard particles." However, it is my opinion that this statement has been misinterpreted, especially in view of Fig. 2 of GB '016 which shows by illustration that the Bi phase particles are larger than the hard particles, since the Bi phase particles surround the hard particles in the cross sectional view of the two particles in the copper alloy matrix. My position has already been set forth in the October 30, 2008 Amendment. In response, the Examiner argues that the description at page 3, line 23 through page 4, line 2 which describes Fig. 2 merely refers to "the cushioning property of the soft Bi-phase" and does not suggest that the Bi particles should be larger than the hard particles.

I would like to clarify what is meant by the cushioning property or embeddability in reference to the hard particle and soft Bi-phase of GB '016. Essentially, the hard particles are embedded in the Bi phase so that the larger Bi-phase particles can prevent the hard particles from "excessively attacking the mating member at the sliding contact surface because of cushioning property of the soft Bi-phase as shown in Fig. 2" (page 3, line 25 to page 4, line 2 of GB '016). In other words, if the hard particle was not embedded in the Bi-phase, it would be mainly supported by Cu matrix and would come into contact with the shaft without cushioning property of Bi phase, thereby damaging and wearing down the shaft. By embedding the hard particle in a soft Bi-phase, the hard particle is provided with a "cushion" so that when it comes in contact with the shaft, the Bi-phase cushion can absorb some of the impact and lessen the damage to the shaft. In this regard, illustrations (A) and (B) are attached hereto which elaborate on this effect.

Also in the October 30, 2008 Amendment, we have further argued that the skilled artisan would be taught away from an embodiment wherein the Bi-phase particles are smaller than the hard particles since the description at page 5, lines 11-16 of GB '016 describes the hard particles by stating:

> If the average grain size exceeds 45 μm, in the case *where the Bi amount is relatively smaller*, there can not be seen the effects of Bi-phase which are properties of cushioning and embeddability for hard particles and the hard particles attack the mating member more intensely. (Emphasis added).

Thus, one of ordinary skill in the art would be motivated to use Bi-phase particles which are <u>larger</u> than the hard particles since larger hard particles cannot imbed in <u>smaller</u> Bi-phase particles. To attempt to do so would prevent the cushioning of the hard particles, thereby allowing them to attack the mating member. The Examiner appears to

agree, in part, with this assessment and concedes that "GB '016 teaches the limitation that the average particle diameter of the hard particles may not exceed 45 μm because they would no longer be able to properly embed in the Bi phase." Since the object of GB '016 is to achieve this embeddability, hard particles which exceed 45 μm would render the invention of GB '016 inoperable. Likewise, Bi-phase particles which were too small to allow the hard particle to embed in them would also render the invention of GB '016 inoperable. I believe that this is the reason for the inclusion of the statement italicized above from GB '016: "where the Bi amount is relatively smaller". See attached illustration (C) for an example of the resulting configuration when the Bi-phase is smaller than the hard particle in the invention of GB '016.

Since GB '016 does not specifically describe the relative sizes of the Bi-phase and hard particles, the skilled artisan would look to the reference as a whole to determine what was intended. In doing so, Fig. 2 and the description at pages 3-5 as discussed above (1) provides motivation to use Bi-phase particles which have a <u>larger</u> average particle diameter than that of the hard particles so that the hard particles may imbed in the Bi-phase particles, and (2) teaches away from using Bi-phase particles which have a smaller average particle diameter relative to the hard particles. Further, when the statement which formed the basis of the rejection ("Bi is prevented to flow out from its initial position through coexisting hard particles") is placed in context, the skilled artisan would readily see that the intent of this statement was to describe how the hard particle should embed in the soft Bi-phase, thereby allowing the larger Bi-phase particles to prevent the hard particles from attacking the mating member at the sliding contact surface.

The rejection states that Applicants have not shown the criticality of the limitation that the Bi-phase has a smaller particle diameter than the hard particles. However, the instant specification presents comparative data as evidence of the criticality, all of which are incorporated by reference. The Examiner's attention is directed to Table 1 of the instant specification. In Comparative Examples 2-6, the diameter of the Bi-phase particles are larger than the hard particles which results in a large adhesion area, poor fatigue resistance and poor corrosion resistance. By contrast, these properties are improved in the Examples of the invention wherein the Bi-phase particle diameter is smaller than that of the hard particles.

Additional evidence of the criticality of the limitation that the Bi-phase has a smaller particle diameter than the hard particles can be seen in the experiments described

in Section I above, wherein the Example 4 from Table 1 of the instant specification is compared to Example 4 from Table 1 of GB '016. While the disclosure of GB '016 specifies the size of the hard particles in Table 1 therein, the specific size of the Bi particles is not mentioned other than as illustrated in Fig. 1A and Fig. 1B (showing Bi particles in a sintered alloy, or *after* sintering). The broader description of Bi particles having a size that is less than or equal to 250 µm refers to the size *before* sintering. Therefore, only the specific example, Fig. 1A, has been used as the basis for these comparisons. The sample prepared according to the present invention is seen in Figures 1 and 2, while the example of GB '016 is represented by Fig. 1A. While the magnification of Fig. 1 and 2 is different from that of Fig 1A, the relative sizes of the Bi particles and hard particles is unaffected by this difference. A measurement of the Bi-phase particles and hard particles showed that the Bi-phase particles of GB '016 were larger than that of the hard particles. Note that the diameter of the Bi-phase of GB '016 was measured to be 28 µm while the hard particles were 17 µm (this measurement differed from that presented in Table 1 of GB '016, probably due to different measuring methods). Thus, the Bi-phase had a larger diameter than the hard particles.

II-A-ii - Issue 2: Sintering Method

The October 30, 2008 Amendment includes arguments that the sintering process of the present invention differs from that of GB '016 in the length of time of the sintering process. In response, the Examiner asserts that this argument has not been supported by factual evidence. I disagree. As previously noted, the facts are presented within GB '016 where it states that the sintering process occurred over the course of 20 min. (page 9, lines 24-27). In the inventive sintering process, a pre-alloy powder of Cu-Bi alloy is sintered at a holding time of 2 min. or shorter (see [0015] and [0017] of the specification). When the Cu-Bi powder is sintered for a very short period of time, fine Bi particles are formed. When Cu powder and Bi powder are sintered for 20 min., as in GB '016, the Bi particles become coarse, and the fine particles achieved by the instant process are not produced.

Therefore, the sintered alloy of GB '016 was not made by a similar method to what was used in preparing the sintered alloy of the invention. Further factual evidence should not be necessary since the description in GB '016 is clear. Since the sintering processes differ, the assumption that the alloy of GB '016 would have an overlapping Bi-phase average particle diameter, contact length ratio and hard particle ratio is incorrect.

<u>II-A-iii - Issue 3: Effect of Sintering Method on the Particles</u>

Regarding the issue of relative particles sizes, the Examiner states, "the Examiner's position is further supported by [0017] of Applicant's own specification which states that the Cu-Bi pre-alloy powder has a particle diameter of 150 μm or less (which is larger than that of the hard particles) *before* preliminary sintering is carried out and that after sintering, the diameter corresponding to a circle of Bi phase has a size ranging from 5-28 μm as seen in Table 1." Based on this excerpt, the Examiner assumes that the grain size of the Bi, Sn, and Cu powders of GB '016 ("not more than 250 μm before sintering") would also be reduced to a size within the scope of Applicants' invention since the compositions and sintering processes of GB '016 allegedly overlap with that of the invention.

However, as previously argued in the October 30, 2008 Amendment, the sintering processes differ between the present invention and that of GB '016 since the instant process is much shorter. The effect of a longer sintering time (as taught in GB '016) is illustrated in the attached Reference Fig. 1. In the case of the Cu-Bi alloy powder, when the sintering process takes place over a long period of time, the Bi-phase or Bi particles grow and coarsen during the process. The same is true in the case of a Cu powder and Bi powder (as described in GB '016). In both situations, the fine Bi particles having a size of 10 μm or less before sintering experience growth and coarsening during a <u>long</u> sintering process. Even if the size of the inventive Bi-phase particles before sintering is the same size as that of GB '016 before sintering, the assumption that the post-sintering particle sizes are the same is in error since the sintering process steps are different. Accordingly, the size of the Bi-phase particles before sintering does not determine the size of the Bi-phase particles after sintering. Instead it is the length of the sintering process that determines the size of the Bi-phase particles after sintering. This is why the inventive process uses a very short sintering time in order to suppress the growth of the Bi-phase or Bi particles.

Based on the disclosure of GB '016, the skilled artisan must speculate as to what the size of the Bi particles were before and after sintering in the Examples. The only tangible evidence of the Bi particle size is seen in Figs. 1A and 1B of GB '016. Therefore, it is against this evidence that the experiment described in Section I, above, demonstrates the non-obvious distinction of the invention.

In summary, the totality of the teaching of GB '016 fails to suggest to the

skilled artisan that the Bi-phase should have a smaller average particle diameter than that of the hard particles as presently claimed. When viewing the reference as a whole, the skilled artisan would recognize the critical nature of the imbeddability requirement of the particles of GB '016 since it is by imbedding the hard particles in the soft Bi-phase that the beneficial effects of the invention as described therein are achieved. This is especially so when considering the combination of (1) the excerpts of GB '016 which teach away from employing Bi particles having a smaller diameter than the hard particles, (2) Figs. 1A and 1B which illustrate the relative sizes of the Bi and hard particles, and (3) the disclosure of the long sintering process which allows the Bi particles to increase in size.

Accordingly, it is my opinion that claims 1, 2, 5 and 6 are not obvious in view of GB '016.

II-B. Invention of claims 3-6

In another aspect of the present invention, a lead-free copper-based sintered alloy is characterized by the following unique properties:

1. The composition contains 1-30 mass % of Bi;
2. The composition contains 0.1-10 mass % of hard particles which have an average particle diameter of 10-50 μm;
3. The composition (as recited in claim 4) contains at least one of:
    a. 1-15 mass % of Sn;
    b. 0.1-5 mass % of Ni; and
    c. 0.5 mass % or less of P; and
4. The hard particles having 50% or less of a contact length ratio with the Bi phase based on the total circumferential length of the hard particle, which is in contact with the Bi phase, are present in a ratio of 70% or more based on the entire number of the hard particles.

II-B-i - Issue 4: Hard Particle Contact Length Ratio

Regarding to the 4th property above, the rejection relies on an inherency argument, with the Examiner stating "since the sintered alloy of GB '016 has an overlapping composition and is made using a similar method as the sintered alloy of the present invention, it would be expected that the sintered alloy of GB '016 would have an overlapping contact length ratio and hard matter particle ratio." However, I believe that the skilled artisan in possession of GB '016 would not expect this feature of the invention to be inherent in the alloy as it is described therein.

The present specification shows that a hard particle contact ratio of 100% means that one or more hard particles are in contact with a particular Bi phase at the entire periphery of the hard particle. In other words, the hard particle is imbedded in, or enveloped by the Bi phase. When the contact ratio is less than 100% but greater than 0%, a portion of the hard particle protrudes out from the Bi phase and is in contact with the copper alloy. According to the present invention, the hard particle contact ratio is 50% or less which decreases the contact between the hard particle and the Bi phase. Additionally, the "presence ratio of hard particles" must be 70% or more. When a presence ratio of hard particles is 100%, all of the hard particles have a contact ratio of 50% or less. When the presence ratio of hard particles is 0%, all of the hard particles have a contact ratio of more than 50%. The present invention limits the presence ratio of hard particles to 70% or more.

Although GB '016 does not specifically describe any value which corresponds to the inventive hard particle contact ratio and presence ratio of hard particles, the skilled artisan could see from Fig. 1A that these values would be outside the scope instantly claimed. Please see Fig. 1A of GB '016 where the hard particle contact ratio has been designated as either large or small. P_s represents hard particles which have 50% or less of a contact length ratio with the Bi phase based on the total length of the hard particle. The "s" indicates that the contact ratio is small. Similarly, P_ℓ represents hard particles which have more than 50% of a contact length ratio with the Bi phase based on the total length of the hard particle, with the "l" indicating that the contact ratio is large. According to Fig. 1(a), $P_s/(P_\ell+P_s) < 50\%$, and thus, the teaching of GB '016 does not satisfy the presently claimed requirement that this value be greater than or equal to 70%.

Additionally, as can be seen at paragraph [0017] of the invention, when the sintering process was carried out over a long period of time, the result was the promotion of the diffusion of the Bi phase, thereby producing the comparative samples which were outside the scope of the invention which carried out the sintering process over a shorter period of time. Therefore, the sintering processes of the present invention and GB '016 are significantly different.

Since this evidence undermines the inherency argument which forms the basis of the rejection of claims 3 and 4 under 35 USC § 103, it is my opinion that the rejection over GB '016 is improper.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statement

and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United Stated code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Hiromi Yokota July 24, 2009

Signature

Hiromi Yokota

Typed or Printed Name

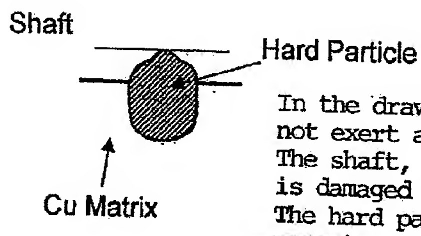
Attachments: Illustrations (A)-(C)
Reference Fig. 1

Illustrations (A)-(C)

GB016 describes that "... it is possible to restrain those exposed on surface of the copper alloy matrix not to excessively attack the matrix member at the sliding surface because of cushoning property of the soft Bi phase ..."

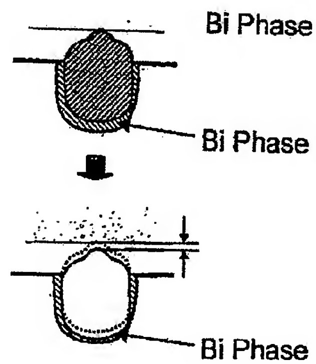
A)

In a case now considered, a hard particle in exposed on the sliding surface of a bearing, which is in contact with a shaft.



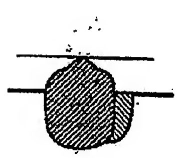
In the drawing, since a Bi phase is absent, it does not exert any influence on the hard particle.
The shaft, which is in contact with the hard particle, is damaged or worn out.
The hard particle has attacking property against the opposite material (shaft).

B)



When a hard particle is incorporated in the Bi phase, since the Bi phase is soft, it acts as if cushion and mitigates attacking on an opposite shaft, which is in contact with the hard particle.

C)

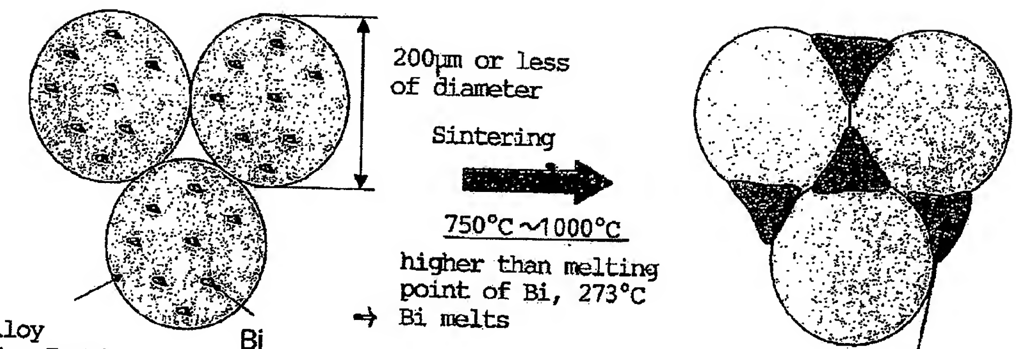


When a Bi phase is smaller than the hard particle, such that a part of the hard particle is in contact with Cu, such Bi phase is less effective to mitigate the attacking property of hard particle than the hard particle incorporated in the Bi phase is. Or, there is no effect at all.

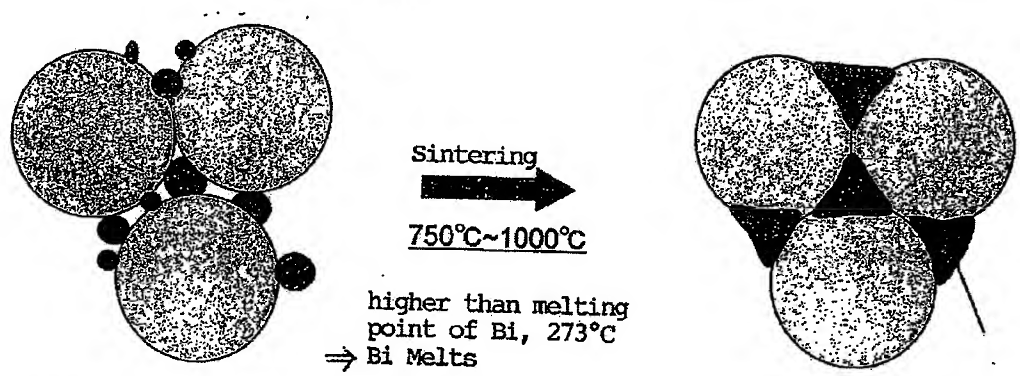
Even if the volumes of Bi phase shown in B) and C) are the same as one another, the effect of Bi phase B) to mitigate attacking property is different from that of Bi phase C). Drawings B) and C) show different positional relationships between the Bi phase and the hard particle. Such positional relationship should be taken into consideration for determining appropriate size of Bi phase.

Reference Fig. 1

Case of Cu-Bi alloy powder



Case of Cu powder and Bi powder



Bi powder finer than Cu powder is mixed with Cu powder

The size of Bi particles or Bi phase before sintering does not determine the size of Bi particles or Bi phase after sintering.